

What is claimed is:

- 1 1. A method for focused ion beam (FIB) gas-assisted etching (GAE) of an integrated
2 circuit die, the method comprising:
3 supplying etch gas, including a halide gas, to the die;
4 etching a selected portion of the die using the etch gas and an ion beam directed at
5 the selected portion; and
6 while etching the die, supplying sufficient oxygen-containing gas to the die to
7 inhibit corrosion of a portion of the copper in the die being exposed to the etch gas.
- 1 2. The method of claim 1, wherein etching the die includes using a vacuum chamber.
- 1 3. The method of claim 2, wherein supplying sufficient oxygen-containing gas
2 includes opening an oxygen-containing gas valve to an oxygen-containing gas supply
3 outlet in the vacuum chamber and maintaining a selected pressure in the chamber.
- 1 4. The method of claim 3, prior to etching the die, further comprising etching a test
2 die in the chamber, the test die having similar copper structure to the die to be etched, and
3 determining therefrom a selected pressure to maintain via the oxygen-containing gas
4 supply that prohibits corrosion of the copper.
- 1 5. The method of claim 3, wherein the pressure in the chamber is maintained between
2 about $5.0\text{e-}6$ and $1.0\text{e-}5$ Torr.

1 6. The method of claim 3, further comprising attaching a nozzle to the oxygen-
2 containing gas supply outlet, the nozzle being adapted to direct oxygen-containing gas to a
3 selected portion of the die during etching.

1 7. The method of claim 1, wherein supplying the etch gas includes supplying
2 sufficient oxygen to the die to inhibit corrosion of a portion of the copper in the die being
3 exposed to the etch gas.

1 8. The method of claim 1, wherein the halide gas includes at least one of: chlorine,
2 bromine and iodine.

1 9. The method of claim 1, wherein the die includes a flip-chip type die having
2 circuitry in a circuit side opposite a back side, and wherein etching the die includes at least
3 one of: etching the die from the circuit side and etching the die from the back side.

1 10. The method of claim 1, wherein supplying sufficient oxygen-containing gas
2 includes using oxygen as a gettering agent.

1 11. The method of claim 1, further comprising detecting a level of halide in the
2 chamber prior to etching the die with an ion beam, wherein etching the die includes etching
3 in response to the detected halide level being below a threshold level defined as a function
4 of the die, the etching and the supplying of oxygen-containing gas.

1 12. The method of claim 1, further comprising detecting a level of halide in the
2 chamber prior to supplying sufficient oxygen-containing gas to the die, wherein supplying
3 sufficient oxygen-containing gas includes supplying an amount of oxygen in response to
4 the detected halide level.

1 13. The method of claim 11, wherein the threshold level of halide is selected such that
2 levels of halide below the threshold level produce an amount of corrosion with copper in
3 the die that is below an acceptable design amount.

1 14. The method of claim 1, wherein supplying sufficient oxygen-based gas includes
2 supplying a gas selected from the group of: oxygen, nitrous-oxide and ozone.

1 15. A system for focused ion beam (FIB) gas-assisted etching (GAE) of an integrated
2 circuit die comprising copper, the system comprising:

3 means for supplying etch gas, including a halide gas, to the die;

4 means for supplying oxygen-containing gas to the die, the oxygen-containing gas
5 supply being sufficient to inhibit corrosion of a portion of the copper in the die being
6 exposed to the etch gas; and

7 means for etching a selected portion of the die using the etch gas and an ion beam
8 directed at the die.

1 16. A system for focused ion beam (FIB) gas-assisted etching (GAE) of an integrated
2 circuit die comprising copper, the system comprising:

3 an etch gas supply adapted to supply etch gas, including a halide gas, to the die;
4 an oxygen-containing gas supply adapted to supply oxygen-containing gas to the
5 die, the oxygen-containing gas supply being sufficient to inhibit corrosion of a portion of
6 the copper in the die being exposed to the etch gas; and
7 an etch device adapted to etch a selected portion of the die using the etch gas and a
8 FIB directed at the die.

1 17. The system of claim 16, further comprising a vacuum chamber adapted to enclose
2 the die for etching.

1 18. The system of claim 17, wherein the etch device is adapted to etch aluminum using
2 the halide and the ion beam.

1 19. The system of claim 17, further comprising a detector located in the vacuum
2 chamber and adapted to detect a level of halide in the chamber.

1 20. The system of claim 19, further comprising a controller coupled to the detector and
2 adapted to control the etch device in response to a halide level detected by the detector.

1 21. The system of claim 20, wherein the controller is further adapted to control the
2 oxygen-containing gas supply in response to a halide level detected by the detector.